August 1997 • NREL/TP-550-23124b

Home Energy Rating System Building Energy Simulation Test for Florida (Florida-HERS BESTEST)

Volume 2
Tier 1 and Tier 2 Tests Reference Results

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This work is divided into two volumes. Volume 1 contains the test cast specifications and is a user's manual for anyone wishing to test a computer program. Volume 2 contains the reference results and suggestions for accrediting agencies on how to use and interpret the results.

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Acronyms and Abbreviations - Volume 1 and Volume 2

A	Area
Abs	Absorptance
Abs In	Inner pane absorptance
Abs Out	Outer pane absorptance
ACH	Air changes per hour
AFUE	Annual Fuel Utilization Efficiency
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
AVG DIST	Exterior wall area weighted window distribution
Base	Base case
BESTEST	Building Energy Simulation Test
Bsmt, Ins	Basement coupled to ground with 2x4 16" o.c. R-11 insulated wall on interior side of poured concrete wall
Bsmt, Unins	Uninsulated basement coupled to ground
C_p	Specific heat
CFM	Cubic feet per minute
Coef	Coefficient
COG	Center of glass
COP	Coefficient of performance
D	Door 3' x 6'8"
dir nor	Direct normal
DLEW	Double pane, low-e window with wood frame and insulated spacer
DOE	Department of Energy
DW	Double pane, clear window with wood frame and metal spacer
EEM	Energy Efficient Mortgage
E/W-Sha	East/west window orientation with overhangs and fins
E/W-Win	East/west window orientation
E,W,N,S	East, west, north, south
EOG	Edge of glass
H	Horizontal overhang projecting perpendicular to window surface
Heatcap	Heat capacity
Hemis	Hemispherical
HERS	Home Energy Rating System
HUD	Housing and Urban Development
HV	Horizontal overhangs and vertical fins projecting perpendicular to window surface
HVAC	Heating, ventilating, and air-conditioning
IEA	International Energy Agency
Ineff	Inefficient building
Infiltr	Infiltration (natural ventilation)
Infl	High infiltration rate
Ins	Well insulated
INSUL	Slab-on-grade or basement with enough insulation to effectively decouple the slab from the ground
Int	Interior
k	Thermal conductivity
LCR	Load to collector area ratio
Low abs	Exterior solar absorptance = 0.2 for selected surfaces
Low-E	Low emissivity
Max	Maximum

Min	Minimum
N/A	Not applicable
NAHB	National Association of Home Builders
NFRC	National Fenestration Rating Council
NREL	National Renewable Energy Laboratory
O.C.	On centers
Orient	Orientation
Pas Base	Passive solar base case
Pas Lo-mass	Passive solar with low mass
Pas N/S/E/W	Passive solar with exterior wall area weighted window distribution
Pas S-Sha	Passive solar with overhang
Pas 0-Win	Passive solar with no windows
Prop	Property
R	Unit thermal resistance
Ref	Reference result
Refl	Reflectance
S-Sha	South window orientation with overhang
S-Win	South window orientation
SATB	Single-pane window with aluminum frame and thermal break
SC	Shading coefficient
S.GL.A	Net south glass area (excluding window frames)
Shade	Window-shading device; horizontal overhang and/or vertical fins
SHGC	Solar heat gain coefficient
SLAB	Slab-on-grade
Slab, Ins	Slab-on-grade with 4' deep perimeter slab insulation
Slab, Unins	Uninsulated slab-on-grade coupled to ground
Surf	Surface
TMY	Typical meteorological year
Trans	Transmittance
T1	Tier 1
T2	Tier 2
U	Unit thermal resistance or overall heat transfer coefficient
UA	Thermal conductance
UA_{inf}	Equivalent thermal conductance due to infiltration
UNINS	Slab-on-grade or basement coupled to ground
UV	Ultraviolet
Val	Value
VC	Vented crawl space
W	Window, 3'x 5'
W_p	Window 2'6" x 5'5"
0-Int	No internal gains
0-Win	No windows
1.0 S	All windows are on the south wall
90% conf	90% confidence interval
α_{ext}	Exterior solar absorptance

3.0 Final Results from Reference Programs: Tables and Graphs

This work is divided into two volumes. Volume 1 contains the test case specifications and is a user's manual for anyone wishing to test a computer program. Volume 2 contains the reference results and suggestions for accrediting agencies on how to use and interpret the results.

Tier 1 reference results are included in the figures and tables of Section 3.4. Tier 2 reference results are presented in the figures and tables of Section 3.5. These results include tables and graphs of annual heating and sensible cooling loads and tables of monthly heating and sensible cooling loads. Additional "delta" tables and graphs show the differences between annual loads (sensitivity to variations) for each case relative to an appropriate base case.

The following programs were used to generate the reference results:

- BLAST 3.0 Level 215
- DOE2.1E - 117
- SUNCODE 5.7.

BLAST is the program the U.S. Department of Defense uses for energy efficiency improvements to its buildings (see *BLAST User Reference, Volumes 1 and 2*). DOE2.1E is considered to be the most advanced of the programs sponsored by the U.S. Department of Energy and is the technical basis for setting national building energy codes and standards in the United States (*DOE-2 Reference Manual [May 1981]; DOE-2 Supplement [January 1994]*). SUNCODE is based on the public domain program SERIRES-1.0 developed by the National Renewable Energy Laboratory (Palmiter *et al.*).

Heating and sensible cooling load reference results were generated using Orlando, Florida TMY weather data with separate simulations for heating only and cooling only as described in section 2.2.10.1 (Volume 1).

Because reference results for slab-on-grade ground coupling include two sets of results (see Section 3.3), the following labeling convention applies to Cases L302 and L304:

- Cases ending in "B" (e.g., L302B) are additional outputs using more detailed ground coupling methods.
- Use of the "AB" suffix in figures designates the combined results of specific "A" and "B" outputs (e.g., L302AB includes all L302A and L302B outputs).

Reference results for basement ground coupling include four sets of results (see Section 3.3). These additional results were required to cover all modeling approaches resulting from two possible ground coupling models and two possible zoning models. The following labeling convention applies to Cases L322 and L324:

- Cases ending in "A1" (e.g., L322A1) use the ASHRAE method for modeling ground coupling with the entire building modeled as a single zone.
- Cases ending in "A2" (e.g., L322A2) use the ASHRAE method for modeling ground coupling with the main floor and basement modeled as separate zones.
- Cases ending in "B1" (e.g., L322B1) use more detailed ground coupling methods with the entire building modeled as a single zone.
- Cases ending in "B2" (e.g., L322B2) use more detailed ground coupling methods with the main floor and basement modeled as separate zones.
- Use of the "AB" suffix in figures designates the combined results of specific "A1," "A2," "B1," and "B2" outputs (e.g., L322AB includes the L322A1, L322A2, L322B1, and L322B2 outputs).

The diskette included with Volume 2 contains the following:

- FHERS2.WK3—Lotus 3.1 spreadsheet file containing reference results. A brief index of the spreadsheet contents is given, starting in cell a:a1 of the spreadsheet, and appropriate spreadsheet addresses are given in small font in the tables.
- FHERS2.FM3—Lotus 3.1 WYSIWYG format file for FHERS2.WK3
- BLAST.ZIP—Compressed input files for BLAST 3.0 reference simulations
- DOE2.ZIP—Compressed input files including custom window library (W4LIB.DAT) for DOE2.1E reference simulations
- SUNCODE.ZIP—Compressed input files for SERIRES/SUNCODE 5.7 reference simulations
- PKUNZIP.EXE—Decompression utility
- README.TXT—Directions for data decompression.

3.1 Comparing with HERS Programs that Designate Heating and Cooling Seasons

Tables of reference monthly heating and cooling load results are provided for comparing HERS tools that designate heating and cooling seasons. For proper comparison with these types of HERS tools, simply sum the appropriate reference monthly load results for the given heating or cooling season. For comparing HERS tools that have heating or cooling seasons, or both, beginning/ending during mid-month, linearly interpolate the monthly reference results for given months as appropriate.

"Delta" results were not tabulated for the monthly results. To develop reference "delta" results for comparison with a HERS tool that designates heating and cooling seasons, do the following. For each set of cases that was compared in the tabulation of the annual "delta" results (see Table 3-2 of Section 3.4 and Table 3-6 of Section 3.5), take the differences of the seasonal sum of monthly reference results (sums per above paragraph). The spreadsheet file on the diskette accompanying this report is helpful for generating seasonal absolute and "delta" results as needed.

3.2 Example Pass/Fail Criteria

A program may be thought of as having successfully passed through the test series when its results compare favorably with the reference program outputs on a case-by-case and sensitivity basis (difference or delta [Δ] between certain cases). An example for developing pass/fail criteria based on a given set of reference results is given in Appendix H (Volume 1); also see HERS BESTEST Chapter 4 (Judkoff and Neymark 1995b, Volume 2). The certifying agency may choose to use the algorithm of Appendix H for developing pass/fail criteria, or it may choose to develop pass/fail criteria using some other method.

3.3 Discussion of Selected Results

3.3.1 Detailed Ground Coupling Analysis Results for Cases L302B, L304B, L322B, and L324B

The results for two types of ground coupling models included in Section 3.4 effectively widen the range of reference results outputs (i.e, ease the passing criteria) for cases that include ground coupling analysis. This was done in case a HERS provider is using a more sophisticated algorithm than the application of ASHRAE steady-state heat transfer coefficients.

Case descriptions for the more detailed simulations of ground coupling in Cases L302B, L304B, L322B, and L324B are provided in Appendix G (Volume 1). Some issues regarding simulation of detailed ground coupling with the reference software are noted below.

In BLAST and DOE2.1E, the mathematical algorithms limit the amount of mass that these programs can effectively model. Where soil thickness (conduction path length) was greater than what a program could handle (generally 2–3 feet, depending on the case), an allowable soil amount was provided and the remaining thickness modeled as steady-state resistance.

In running the reference simulations, which are restricted to one-dimensional heat-flow modeling, the following methods were applied to approximate solar incidence on soil adjacent to the house:

- In BLAST, DOE2.1E, and SERIRES/SUNCODE, slab floors were associated with a skyward-facing, horizontal solar-receiving surface, and exterior solar absorptance was reduced from 0.6 to 0.375 to account for shading half of direct beam radiation at any given time. Because BLAST automatically accounts for shading by the building, the horizontal receiving surface was located on the south side of the building to avoid double counting the shading effect.

- In DOE2.1E and SERIRES/SUNCODE, below-grade walls were associated with a skyward-facing, horizontal solar-receiving surface, and exterior solar absorptance was reduced from 0.6 to 0.375 to account for shading half of direct beam radiation at any given time.

- In BLAST, below-grade walls were associated with skyward-facing, horizontal solar-receiving surfaces, exterior solar absorptance was kept at 0.6, and the horizontal receiving surfaces were positioned to be automatically shaded by the building.

3.3.2 Additional Basement Results for One- and Two-Zone Models

HERS BESTEST allows Cases L322A and L324A (basement series) to be modeled as one large zone or as two smaller zones (main floor and basement as separate zones) as described in the Volume 1 case descriptions. In certain cases, there was enough variation between the one- and two-zone results to justify publishing a complete set of both results. Therefore, the basement results include four outputs for each reference simulation of each case:

- ASHRAE simplified ground coupling, one zone (output designation = A1)
- ASHRAE simplified ground coupling, two zone (output designation = A2)
- Detailed ground coupling, one zone (output designation = B1)
- Detailed ground coupling, two zone (output designation = B2).

Because there are three reference simulation programs, there are a total of 12 reference outputs for each basement case.

3.3.3 Exterior Surface Coefficient Effects

Part of the spread among the reference results can be explained by different assumptions regarding treatment of heat transfer between external surfaces and the surrounding environment. This is especially evident in the Case L200A heating load output. A sensitivity test with SERIRES/SUNCODE using Colorado Springs, CO weather data - when comparing results using the combined exterior surface coefficients specified in Volume

1 versus those calculated by DOE2.1E (DOE2.1E's annualized average was input to SERIRES/SUNCODE) - indicates the following annual heating loads for Case L200A:

- SERIRES/SUNCODE with Volume 1 exterior surface coefficient: 168 MBtu/y heating
- SERIRES/SUNCODE with DOE2.1E calculated exterior surface coefficient: 151 MBtu/y heating.

The roughly 10% effect of this parameter represents a legitimate algorithmic difference between the reference programs. However, future research examining the preferred use of one algorithm over the other is justified by the magnitude of this effect.

3.4 Tier 1 Reference Results

The following figures and tables present the Tier 1 reference results.

- Figure 3-1. Florida-HERS BESTEST Tier 1 reference results—annual heating load (L100A through L170A) for Orlando, FL
- Figure 3-2. Florida-HERS BESTEST Tier 1 reference results—annual heating load (L200A through L324AB) for Orlando, FL
- Figure 3-3. Florida-HERS BESTEST Tier 1 reference results—delta annual heating load (L100A through L170A) for Orlando, FL
- Figure 3-4. Florida-HERS BESTEST Tier 1 reference results—delta annual heating load (L200A through L324AB) for Orlando, FL
- Figure 3-5. Florida-HERS BESTEST Tier 1 reference results—annual cooling load for Orlando, FL
- Figure 3-6. Florida-HERS BESTEST Tier 1 reference results—delta annual cooling load for Orlando, FL
- Table 3-1. Florida-HERS BESTEST Tier 1 reference results—Annual Heating and Cooling Loads for Orlando, FL
- Table 3-2. Florida-HERS BESTEST Tier 1 Reference Results—Delta Annual Heating and Cooling Loads for Orlando, FL
- Table 3-3. Florida-HERS BESTEST Tier 1 Reference Results—Monthly Heating Loads for Cases L100A through L202A for Orlando, FL
- Table 3-4. Florida-HERS BESTEST Tier 1 Reference Results—Monthly Heating Loads for Cases L302A through L324B2 for Orlando, FL
- Table 3-5. Florida-HERS BESTEST Tier 1 Reference Results—Monthly Sensible Cooling Loads for Cases L100A through L202A for Orlando, FL

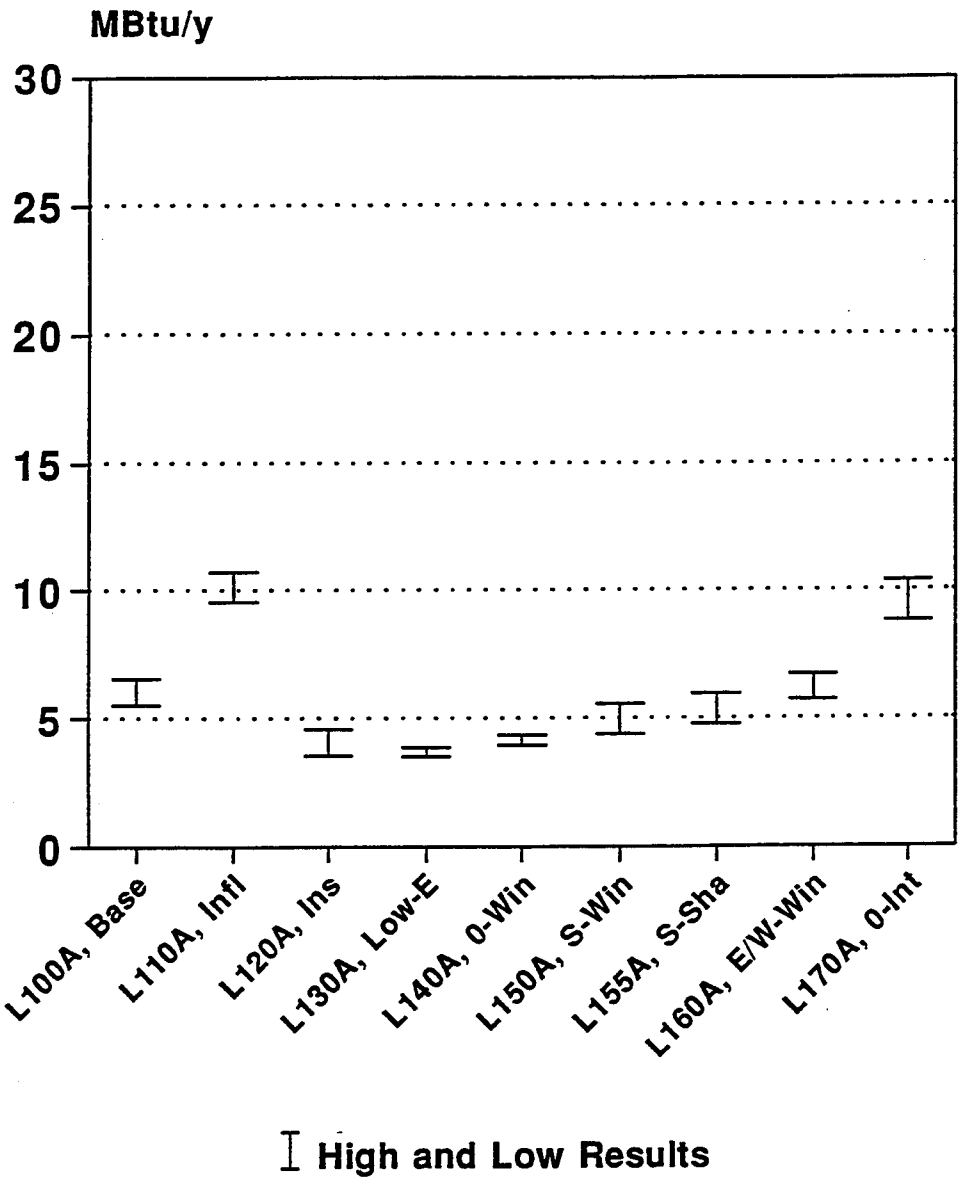

Figure 3-1. Florida-HERS BESTEST Tier 1 reference results—annual heating load (L100A through L170A) for Orlando, FL

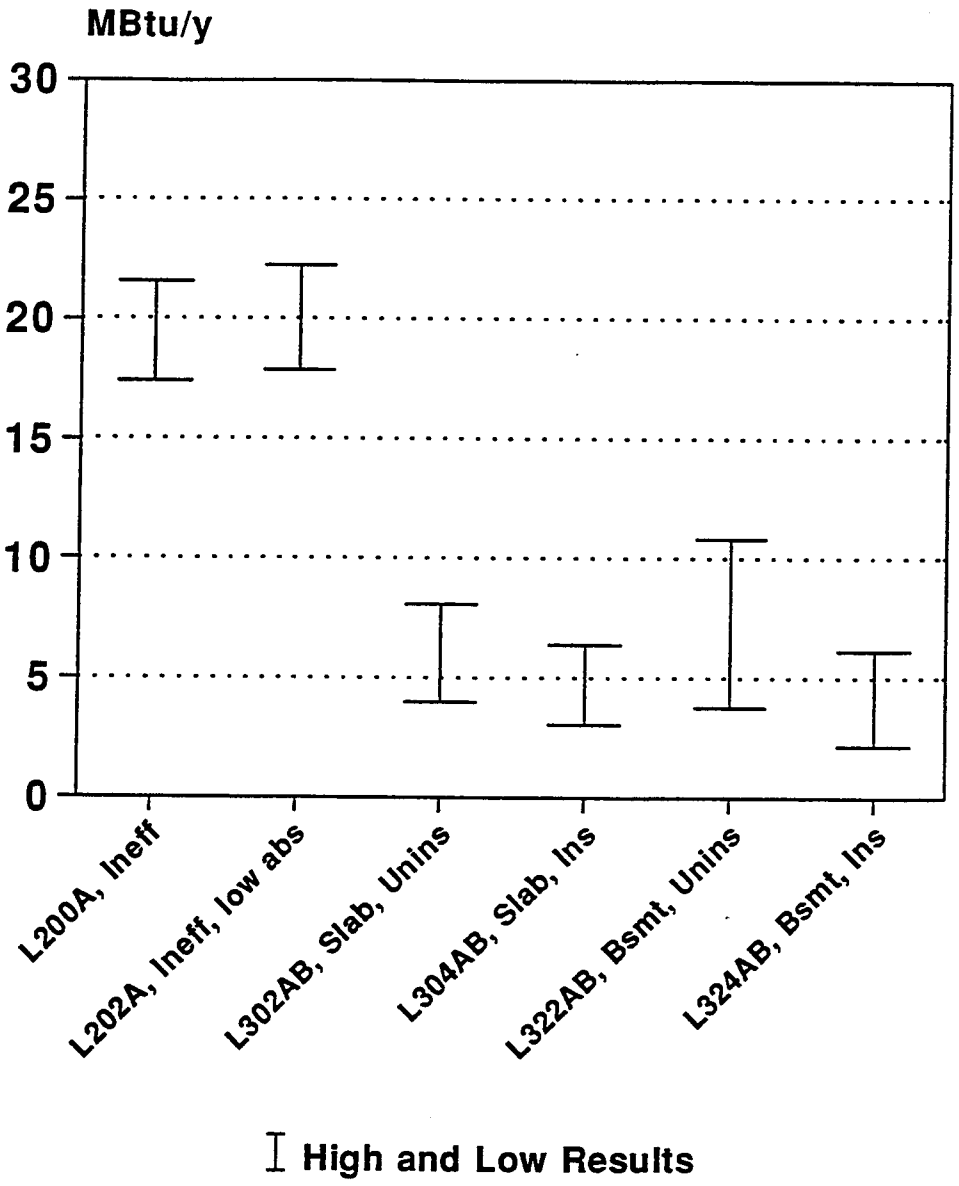

Figure 3-2. Florida-HERS BESTEST Tier 1 reference results—annual heating load (L200A through L324AB) for Orlando, FL

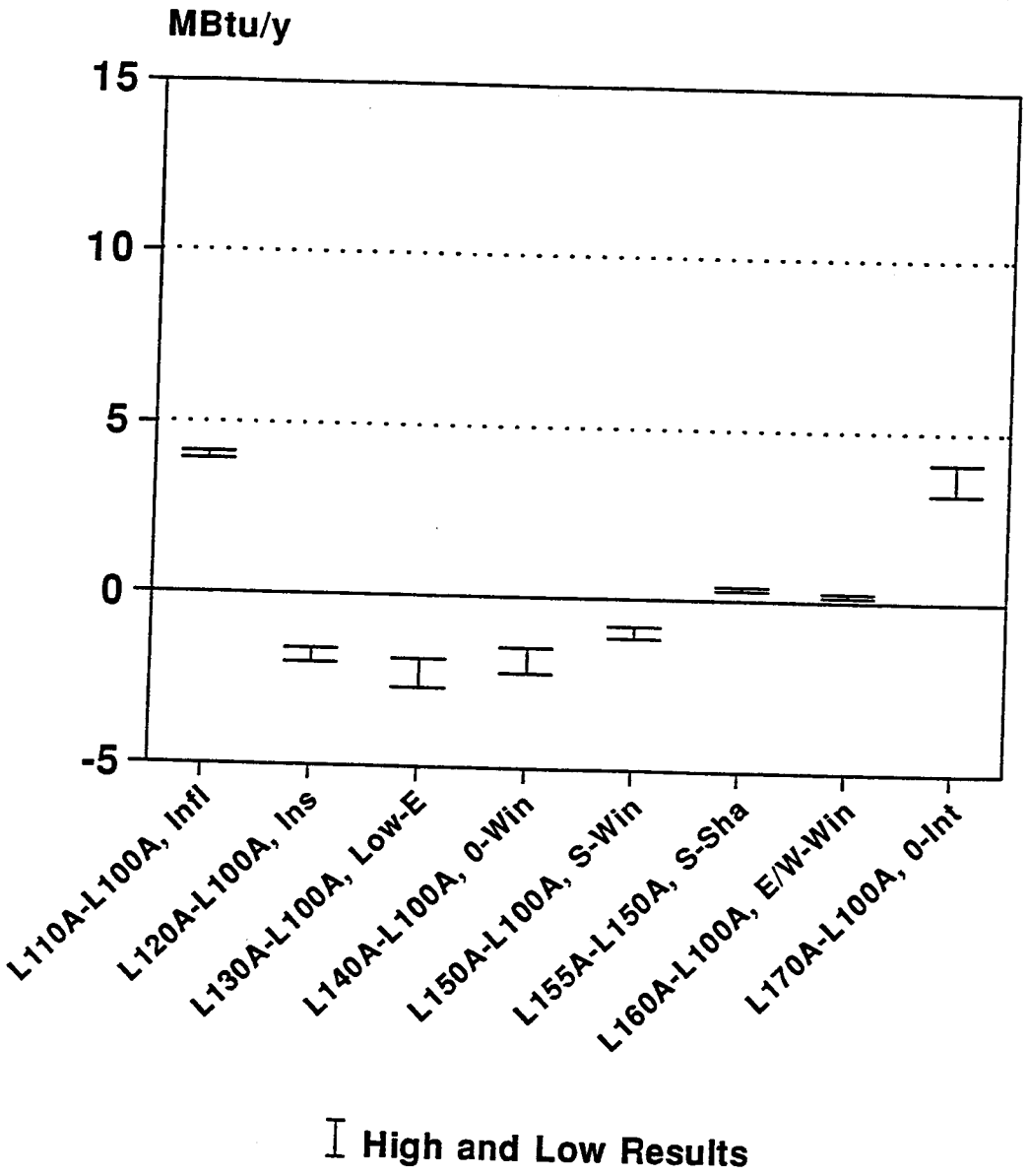

Figure 3-3. Florida-HERS BESTEST Tier 1 reference results—delta annual heating load (L100A through L170A) for Orlando, FL

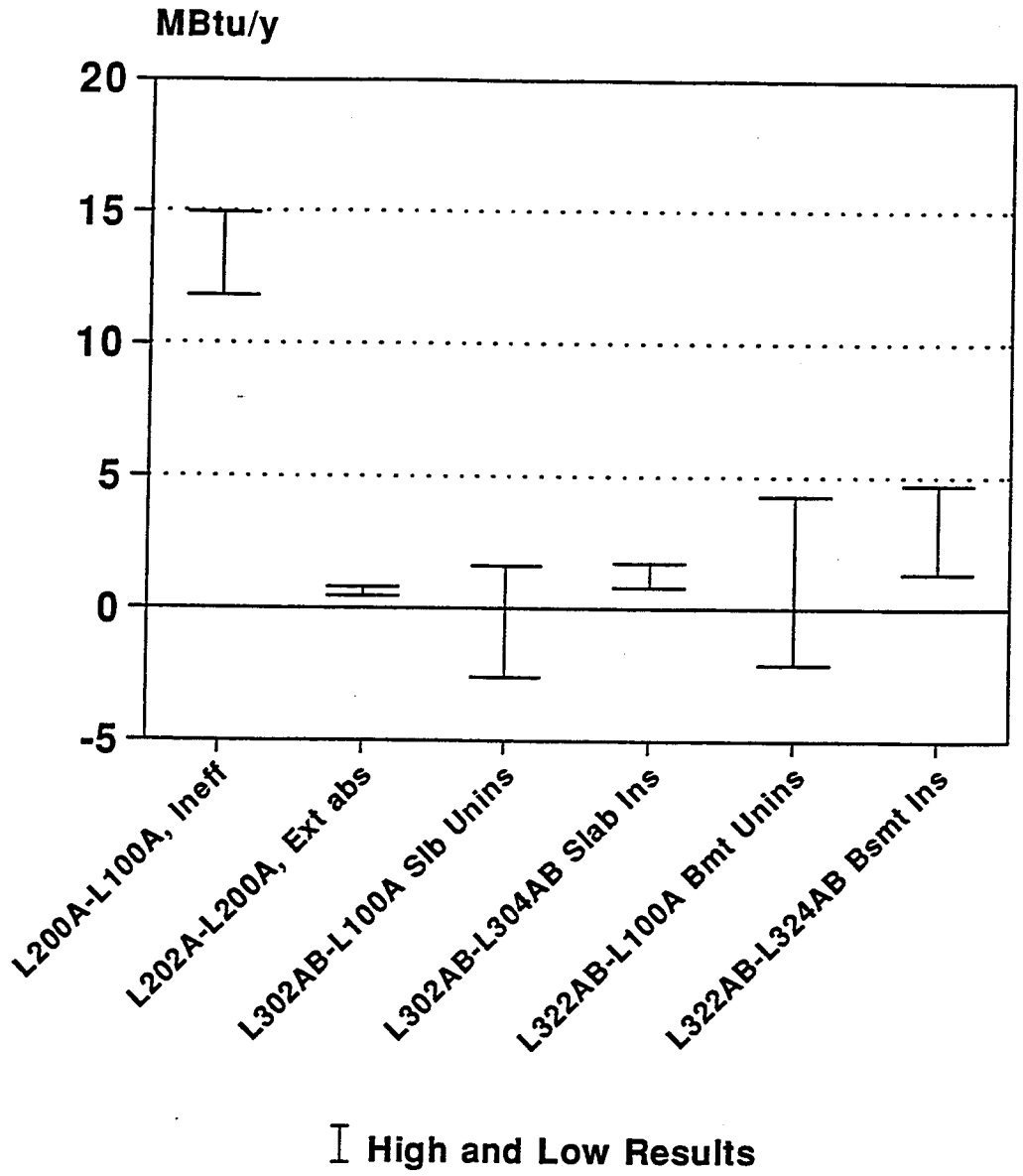

Figure 3-4. Florida-HERS BESTEST Tier 1 reference results—delta annual heating load (L200A through L324AB) for Orlando, FL

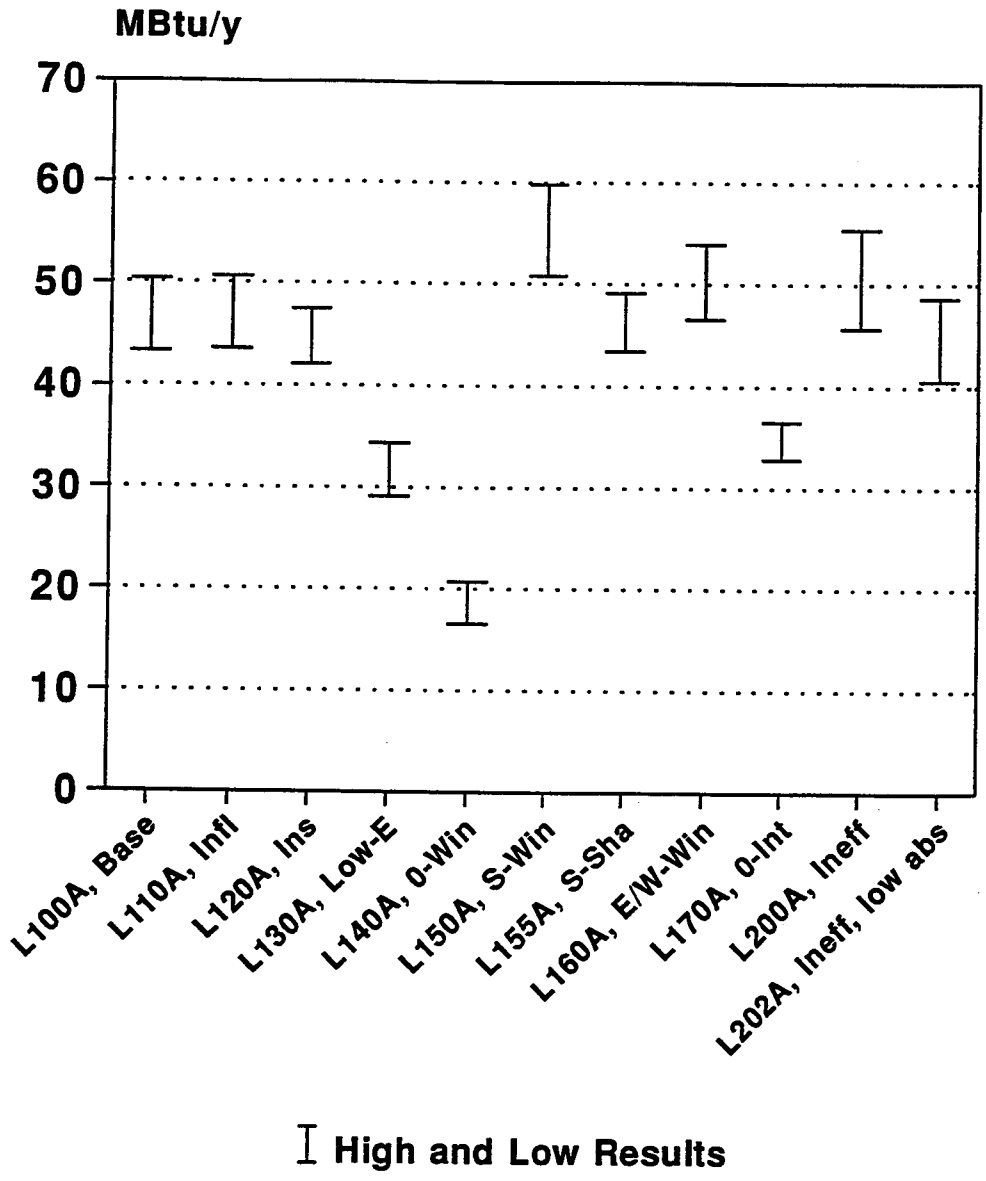

Figure 3-5. Florida-HERS BESTEST Tier 1 reference results—annual sensible cooling load for Orlando, FL

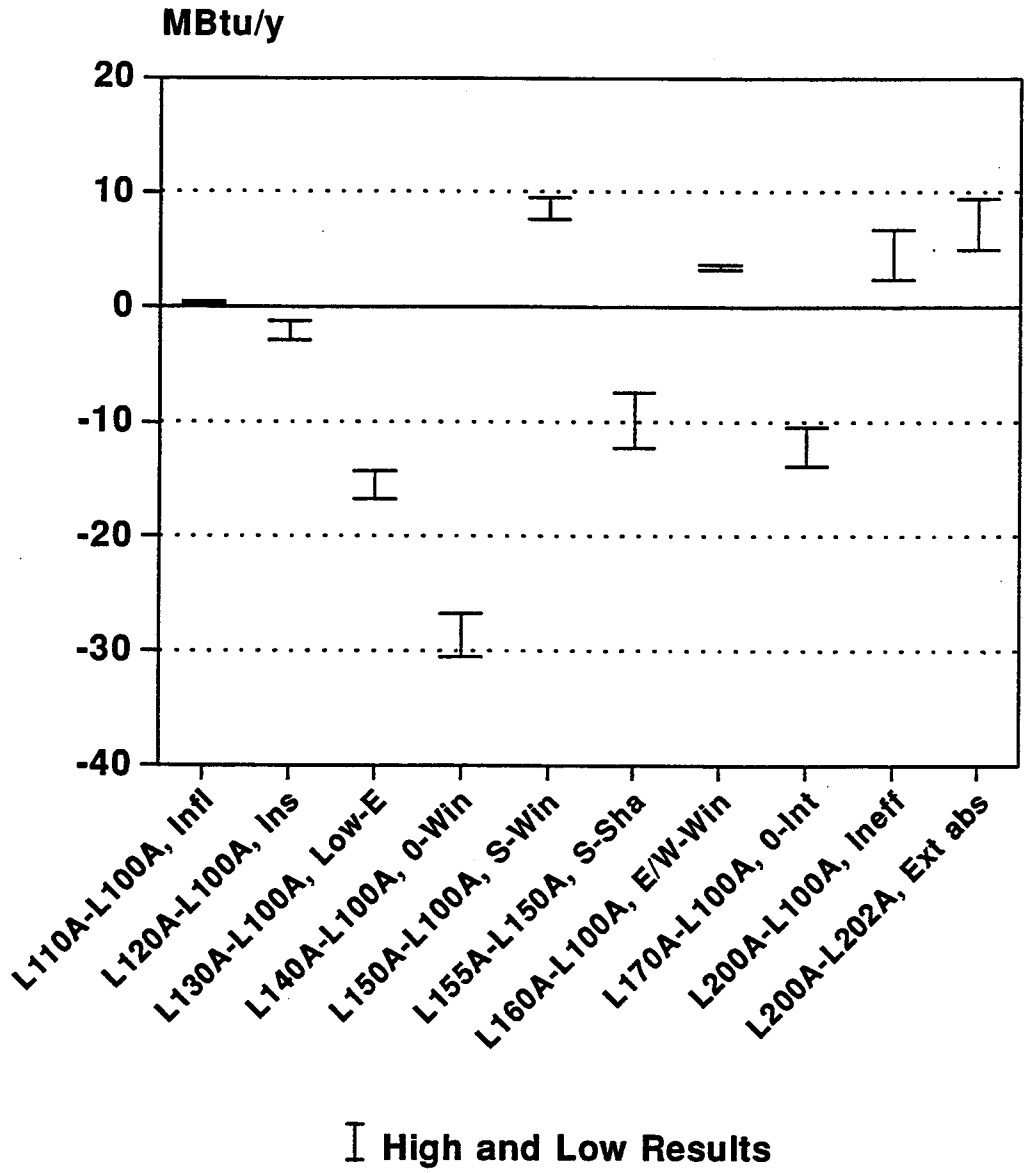

Figure 3-6. Florida-HERS BESTEST Tier 1 reference results—delta annual sensible cooling load for Orlando, FL

Table 3-1. Florida-HERS BESTEST Tier 1 Reference Results—Annual Heating and Sensible Cooling Loads for Orlando, FL

Annual Heating (MBtu/y)			SERIRES/	Annual Cooling (MBtu/y)			SERIRES/
Case #	BLAST	DOE2	SUNCODE	Case #	BLAST	DOE2	SUNCODE
L100A	5.59	5.54	6.56	L100A	43.34	50.39	48.81
L110A	9.54	9.69	10.71	L110A	43.61	50.72	49.30
L120A	3.99	3.56	4.57	L120A	42.11	47.57	45.93
L130A	3.52	3.69	3.86	L130A	29.10	34.46	32.06
L140A	3.95	4.06	4.34	L140A	16.55	20.75	18.26
L150A	4.80	4.37	5.55	L150A	50.95	59.92	57.36
L155A	5.10	4.78	5.95	L155A	43.53	47.71	49.20
L160A	5.74	5.81	6.71	L160A	46.65	54.07	52.13
L170A	8.78	9.65	10.37	L170A	32.95	36.63	36.61
L200A	17.41	19.29	21.55	L200A	45.75	54.51	55.58
L202A	17.87	20.11	22.24	L202A	40.69	45.02	48.72
L302A	7.14	7.14	8.09				
L302B	4.00	4.10	3.96				
L304A	5.66	5.69	6.36				
L304B	3.18	3.08	3.03				
L322A1	9.28	9.79	10.42				
L322A2	8.94	8.67	10.82				
L322B1	3.75	3.96	4.44				
L322B2	5.53	6.05	5.81				
L324A1	5.49	5.64	5.94				
L324A2	5.22	4.98	6.15				
L324B1	2.40	2.13	2.78				
L324B2	3.70	3.57	4.05				

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Table 3-2. Florida-HERS BESTEST Tier 1 Reference Results— Delta Annual Heating and Sensible Cooling Loads for Orlando, FL

Delta Annual Heating (MBtu/y) Case	BLAST	DOE2	SERIRES/ SUNCODE
L110A-L100A	3.95	4.15	4.15
L120A-L100A	-1.61	-1.98	-1.99
L130A-L100A	-2.07	-1.85	-2.70
L140A-L100A	-1.64	-1.48	-2.22
L150A-L100A	-0.80	-1.17	-1.01
L155A-L150A	0.31	0.41	0.40
L160A-L100A	0.15	0.28	0.15
L170A-L100A	3.19	4.11	3.81
L200A-L100A	11.81	13.75	14.99
L202A-L200A	0.47	0.82	0.69
L302A-L100A	1.54	1.60	1.53
L302B-L100A	-1.59	-1.44	-2.60
L302A-L304A	1.48	1.45	1.73
L302B-L304B	0.82	1.02	0.92
L322A1-L100A	3.69	4.25	3.86
L322A2-L100A	3.34	3.14	4.26
L322B1-L100A	-1.84	-1.58	-2.12
L322B2-L100A	-0.06	0.51	-0.75
L322A1-L324A1	3.78	4.15	4.47
L322A2-L324A2	3.72	3.70	4.67
L322B1-L324B1	1.35	1.83	1.67
L322B2-L324B2	1.83	2.47	1.76

Delta Annual Cooling (MBtu/y) Case	BLAST	DOE2	SERIRES/ SUNCODE
L110A-L100A	0.27	0.32	0.49
L120A-L100A	-1.23	-2.83	-2.89
L130A-L100A	-14.24	-15.94	-16.76
L140A-L100A	-26.79	-29.64	-30.56
L150A-L100A	7.61	9.53	8.55
L155A-L150A	-7.42	-12.21	-8.16
L160A-L100A	3.31	3.68	3.31
L170A-L100A	-10.39	-13.76	-12.20
L200A-L100A	2.41	4.12	6.77
L202A-L200A	5.06	9.49	6.86

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Table 3-3. Florida-HERS BESTEST Tier 1 Reference Results— Monthly Heating Loads for Cases L100A through L202A for Orlando, FL

BLAST 3.0 Monthly and Total Heating Loads (MBtu/y)											
	L100A	L110A	L120A	L130A	L140A	L150A	L155A	L160A	L170A	L200A	L202A
Jan	2.20	3.47	1.68	1.53	1.67	1.91	1.98	2.29	3.07	5.72	5.86
Feb	0.76	1.36	0.50	0.44	0.53	0.63	0.70	0.76	1.29	2.61	2.68
Mar	0.43	0.86	0.26	0.21	0.23	0.40	0.47	0.41	0.81	1.80	1.85
Apr	0.08	0.21	0.05	0.04	0.05	0.09	0.11	0.07	0.20	0.65	0.67
May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct	0.03	0.10	0.01	0.00	0.00	0.02	0.02	0.03	0.10	0.31	0.32
Nov	0.23	0.54	0.10	0.08	0.09	0.16	0.18	0.25	0.54	1.23	1.27
Dec	-1.86	3.00	1.39	1.23	1.38	1.59	1.64	1.94	2.77	5.08	5.21
Tot	5.59	9.54	3.99	3.52	3.95	4.80	5.10	5.74	8.78	17.41	17.87

DOE2.1E Monthly and Total Heating Loads (MBtu/y)											
	L100A	L110A	L120A	L130A	L140A	L150A	L155A	L160A	L170A	L200A	L202A
Jan	2.12	3.42	1.50	1.52	1.66	1.70	1.80	2.23	3.21	6.08	6.33
Feb	0.77	1.41	0.45	0.49	0.55	0.59	0.65	0.80	1.45	2.90	3.03
Mar	0.44	0.89	0.23	0.25	0.27	0.39	0.45	0.42	0.93	2.04	2.14
Apr	0.10	0.27	0.04	0.05	0.06	0.10	0.14	0.08	0.30	0.88	0.93
May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.08
Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct	0.04	0.12	0.01	0.01	0.01	0.02	0.04	0.05	0.15	0.40	0.41
Nov	0.27	0.61	0.10	0.12	0.13	0.16	0.21	0.32	0.68	1.49	1.56
Dec	1.80	2.97	1.22	1.25	1.38	1.40	1.50	1.91	2.93	5.42	5.64
Tot	5.54	9.69	3.56	3.69	4.06	4.37	4.78	5.81	9.65	19.29	20.11

SERIRES/SUNCODE 5.7 Monthly and Total Heating Loads (MBtu/y)											
	L100A	L110A	L120A	L130A	L140A	L150A	L155A	L160A	L170A	L200A	L202A
Jan	2.55	3.86	1.91	1.66	1.79	2.20	2.28	2.65	3.56	7.07	7.27
Feb	0.92	1.56	0.60	0.50	0.59	0.76	0.84	0.92	1.56	3.26	3.38
Mar	0.48	0.93	0.27	0.21	0.27	0.45	0.54	0.43	0.94	2.19	2.28
Apr	0.10	0.24	0.05	0.04	0.06	0.10	0.13	0.08	0.25	0.77	0.82
May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03
Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct	0.03	0.11	0.01	0.00	0.01	0.02	0.02	0.04	0.13	0.37	0.39
Nov	0.30	0.65	0.13	0.10	0.13	0.20	0.23	0.32	0.69	1.57	1.61
Dec	2.19	3.36	1.61	1.35	1.50	1.84	1.90	2.28	3.23	6.29	6.47
Tot	6.56	10.71	4.57	3.86	4.34	5.55	5.95	6.71	10.37	21.55	22.24

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Table 3-4. Florida-HERS BESTEST Tier 1 Reference Results— Monthly Heating Loads for Cases L302A through L324B2 for Orlando, FL

BLAST 3.0 Monthly and Total Heating Loads (MBtu/y)												
	L302A	L302B	L304A	L304B	L322A1	L322A2	L322B1	L322B2	L324A1	L324A2	L324B1	L324B2
Jan	2.60	1.84	2.16	1.50	3.43	3.39	2.04	2.58	2.24	2.20	1.36	1.70
Feb	1.01	0.48	0.78	0.38	1.31	1.25	0.25	0.60	0.72	0.66	0.13	0.46
Mar	0.64	0.13	0.47	0.09	0.80	0.73	0.02	0.20	0.38	0.32	0.01	0.14
Apr	0.16	0.02	0.10	0.01	0.19	0.16	0.00	0.03	0.07	0.06	0.00	0.02
May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct	0.08	0.00	0.05	0.00	0.09	0.06	0.00	0.00	0.01	0.00	0.00	0.00
Nov	0.40	0.04	0.27	0.02	0.49	0.41	0.00	0.06	0.17	0.13	0.00	0.03
Dec	2.23	1.49	1.83	1.18	2.97	2.95	1.44	2.06	1.89	1.84	0.90	1.34
Tot	7.14	4.00	5.66	3.18	9.28	8.94	3.75	5.53	5.49	5.22	2.40	3.70

DOE2.1E Monthly and Total Heating Loads (MBtu/y)												
	L302A	L302B	L304A	L304B	L322A1	L322A2	L322B1	L322B2	L324A1	L324A2	L324B1	L324B2
Jan	2.55	1.84	2.10	1.46	3.45	3.23	2.12	2.73	2.20	2.07	1.24	1.59
Feb	1.03	0.51	0.80	0.35	1.41	1.21	0.26	0.65	0.77	0.64	0.09	0.46
Mar	0.65	0.12	0.49	0.07	0.90	0.72	0.01	0.20	0.43	0.31	0.00	0.14
Apr	0.19	0.02	0.12	0.01	0.29	0.18	0.00	0.03	0.09	0.06	0.00	0.02
May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct	0.09	0.00	0.06	0.00	0.13	0.08	0.00	0.00	0.03	0.01	0.00	0.00
Nov	0.44	0.07	0.32	0.03	0.61	0.46	0.00	0.11	0.25	0.15	0.00	0.05
Dec	2.20	1.54	1.79	1.17	2.99	2.80	1.58	2.32	1.87	1.74	0.80	1.30
Tot	7.14	4.10	5.69	3.08	9.79	8.67	3.96	6.05	5.64	4.98	2.13	3.57

SERIRES/SUNCODE 5.7 Monthly and Total Heating Loads (MBtu/y)												
	L302A	L302B	L304A	L304B	L322A1	L322A2	L322B1	L322B2	L324A1	L324A2	L324B1	L324B2
Jan	2.97	1.81	2.42	1.43	3.88	3.97	2.49	2.88	2.45	2.50	1.65	1.93
Feb	1.17	0.57	0.90	0.44	1.50	1.56	0.67	0.89	0.79	0.83	0.44	0.64
Mar	0.68	0.09	0.49	0.06	0.83	0.89	0.08	0.29	0.35	0.38	0.07	0.25
Apr	0.16	0.00	0.10	0.00	0.19	0.22	0.00	0.05	0.06	0.07	0.00	0.04
May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct	0.08	0.00	0.04	0.00	0.08	0.09	0.00	0.00	0.01	0.01	0.00	0.00
Nov	0.46	0.01	0.32	0.00	0.57	0.59	0.00	0.07	0.19	0.21	0.00	0.03
Dec	2.57	1.47	2.09	1.10	3.37	3.49	1.21	1.64	2.08	2.15	0.62	1.15
Tot	8.09	3.96	6.36	3.03	10.42	10.82	4.44	5.81	5.94	6.15	2.78	4.05

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Table 3-5. Florida-HERS BESTEST Tier 1 Reference Results— Monthly Sensible Cooling Loads for Cases L100A through L202A for Orlando, FL

BLAST 3.0 Monthly and Total Sensible Cooling Loads (MBtu/y)											
	L100A	L110A	L120A	L130A	L140A	L150A	L155A	L160A	L170A	L200A	L202A
Jan	0.76	0.61	0.81	0.28	0.01	2.19	1.73	0.43	0.47	0.56	0.40
Feb	1.09	0.88	1.16	0.46	0.08	2.38	1.57	0.91	0.68	0.80	0.62
Mar	2.34	2.19	2.38	1.31	0.37	3.25	2.10	2.49	1.71	2.18	1.86
Apr	3.11	2.93	3.10	1.93	0.72	3.16	2.35	3.88	2.28	2.87	2.44
May	5.13	5.24	4.92	3.55	2.01	4.67	4.43	6.17	4.04	5.62	5.00
Jun	5.92	6.18	5.63	4.25	2.72	5.51	5.43	6.67	4.65	6.64	6.00
Jul	6.55	6.95	6.18	4.78	3.23	6.13	6.03	7.38	5.20	7.62	6.95
Aug	6.48	6.87	6.10	4.74	3.23	6.33	5.81	7.25	5.10	7.54	6.86
Sep	5.17	5.36	5.00	3.71	2.36	5.54	4.61	5.53	3.94	5.60	5.13
Oct	3.93	3.89	3.87	2.65	1.37	5.35	4.26	3.83	2.95	3.91	3.46
Nov	2.31	2.13	2.35	1.32	0.46	4.39	3.58	1.86	1.67	2.09	1.74
Dec	0.54	0.39	0.60	0.13	0.00	2.05	1.63	0.26	0.27	0.35	0.24
Tot	43.34	43.61	42.11	29.10	16.55	50.95	43.53	46.65	32.95	45.75	40.69

DOE2.1E Monthly and Total Sensible Cooling Loads (MBtu/y)											
	L100A	L110A	L120A	L130A	L140A	L150A	L155A	L160A	L170A	L200A	L202A
Jan	1.26	1.04	1.27	0.55	0.05	3.23	2.55	0.83	0.79	1.06	0.69
Feb	1.72	1.44	1.71	0.81	0.18	3.45	2.54	1.46	1.10	1.40	0.96
Mar	3.05	2.86	2.94	1.78	0.64	4.20	2.92	3.30	2.16	2.99	2.32
Apr	3.79	3.61	3.61	2.43	1.12	3.87	2.65	4.76	2.68	3.72	2.87
May	5.66	5.82	5.25	4.03	2.52	5.00	4.40	6.91	4.27	6.43	5.33
Jun	6.39	6.72	5.91	4.74	3.29	5.68	5.29	7.29	4.78	7.36	6.29
Jul	6.98	7.45	6.43	5.25	3.78	6.31	5.87	7.93	5.26	8.28	7.18
Aug	6.90	7.37	6.37	5.19	3.74	6.67	5.78	7.75	5.18	8.20	7.08
Sep	5.81	6.04	5.49	4.25	2.88	6.37	4.76	6.16	4.23	6.43	5.58
Oct	4.71	4.68	4.52	3.22	1.81	6.46	4.46	4.55	3.41	4.86	4.01
Nov	3.09	2.87	3.02	1.84	0.69	5.59	4.16	2.52	2.18	2.96	2.24
Dec	1.02	0.81	1.04	0.37	0.03	3.08	2.33	0.61	0.58	0.82	0.49
Tot	50.39	50.72	47.57	34.46	20.75	59.92	47.71	54.07	36.63	54.51	45.02

SERIRES/SUNCODE 5.7 Monthly and Total Sensible Cooling Loads (MBtu/y)											
	L100A	L110A	L120A	L130A	L140A	L150A	L155A	L160A	L170A	L200A	L202A
Jan	0.83	0.68	0.82	0.31	0.02	2.37	1.87	0.50	0.50	0.68	0.47
Feb	1.30	1.08	1.27	0.58	0.11	2.72	1.86	1.08	0.81	1.06	0.77
Mar	2.79	2.62	2.66	1.57	0.51	3.75	2.53	2.95	2.01	2.85	2.32
Apr	3.68	3.51	3.49	2.26	0.94	3.78	2.82	4.46	2.69	3.75	3.05
May	5.72	5.87	5.33	3.84	2.19	5.25	4.98	6.82	4.45	6.80	5.97
Jun	6.56	6.86	6.12	4.58	2.92	6.12	6.06	7.35	5.09	7.90	7.11
Jul	7.24	7.68	6.70	5.13	3.45	6.81	6.68	8.10	5.65	9.01	8.21
Aug	7.10	7.54	6.59	5.04	3.41	6.99	6.39	7.88	5.50	8.83	8.07
Sep	5.94	6.14	5.58	4.16	2.63	6.43	5.33	6.26	4.47	6.90	6.21
Oct	4.47	4.44	4.28	2.95	1.53	6.06	4.89	4.32	3.31	4.81	4.18
Nov	2.57	2.40	2.51	1.46	0.52	4.85	4.02	2.07	1.83	2.54	2.08
Dec	0.62	0.47	0.60	0.18	0.02	2.23	1.78	0.34	0.31	0.46	0.30
Tot	48.81	49.30	45.93	32.06	18.26	57.36	49.20	52.13	36.61	55.58	48.72

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3.5 Tier 2 Reference Results

The following figures and tables present the Tier 2 reference results.

- Figure 3-7. Florida-HERS BESTEST Tier 2 reference results—annual heating load for Orlando, FL
- Figure 3-8. Florida-HERS BESTEST Tier 2 reference results—annual sensible cooling load for Orlando, FL
- Figure 3-9. Florida-HERS BESTEST Tier 2 reference results—delta annual heating load for Orlando, FL
- Figure 3-10. Florida-HERS BESTEST Tier 2 reference results—delta annual sensible cooling load for Orlando, FL
- Table 3-6. Florida-HERS BESTEST Tier 2 Reference Results—Annual Heating and Sensible Cooling Loads for Orlando, FL
- Table 3-7. Florida-HERS BESTEST Tier 2 Reference Results—Monthly Heating Loads for Orlando, FL
- Table 3-8. Florida-HERS BESTEST Tier 2 Reference Results—Monthly Sensible Cooling Loads for Orlando, FL.

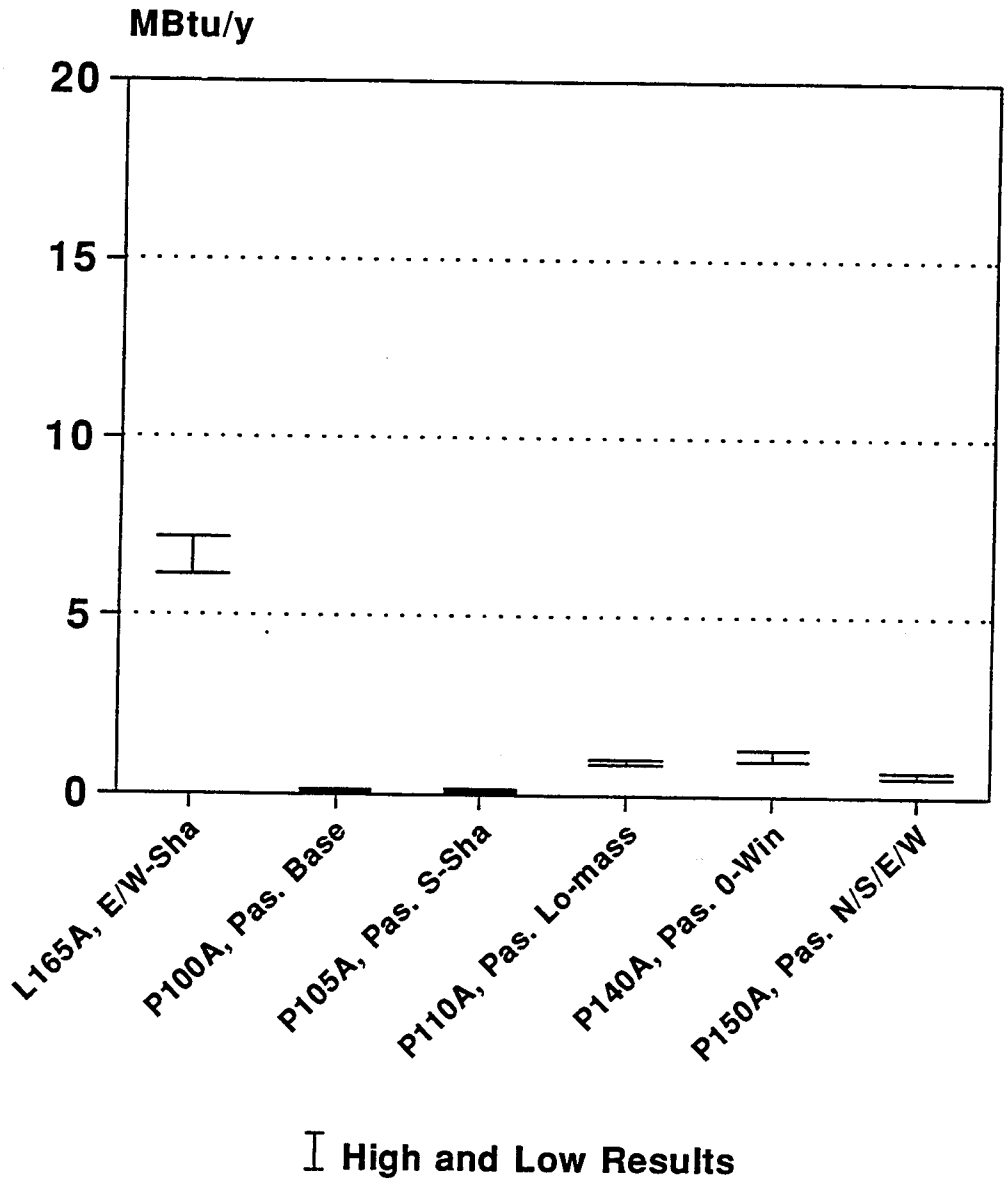

Figure 3-7. Florida-HERS BESTEST Tier 2 reference results—annual heating load for Orlando, FL

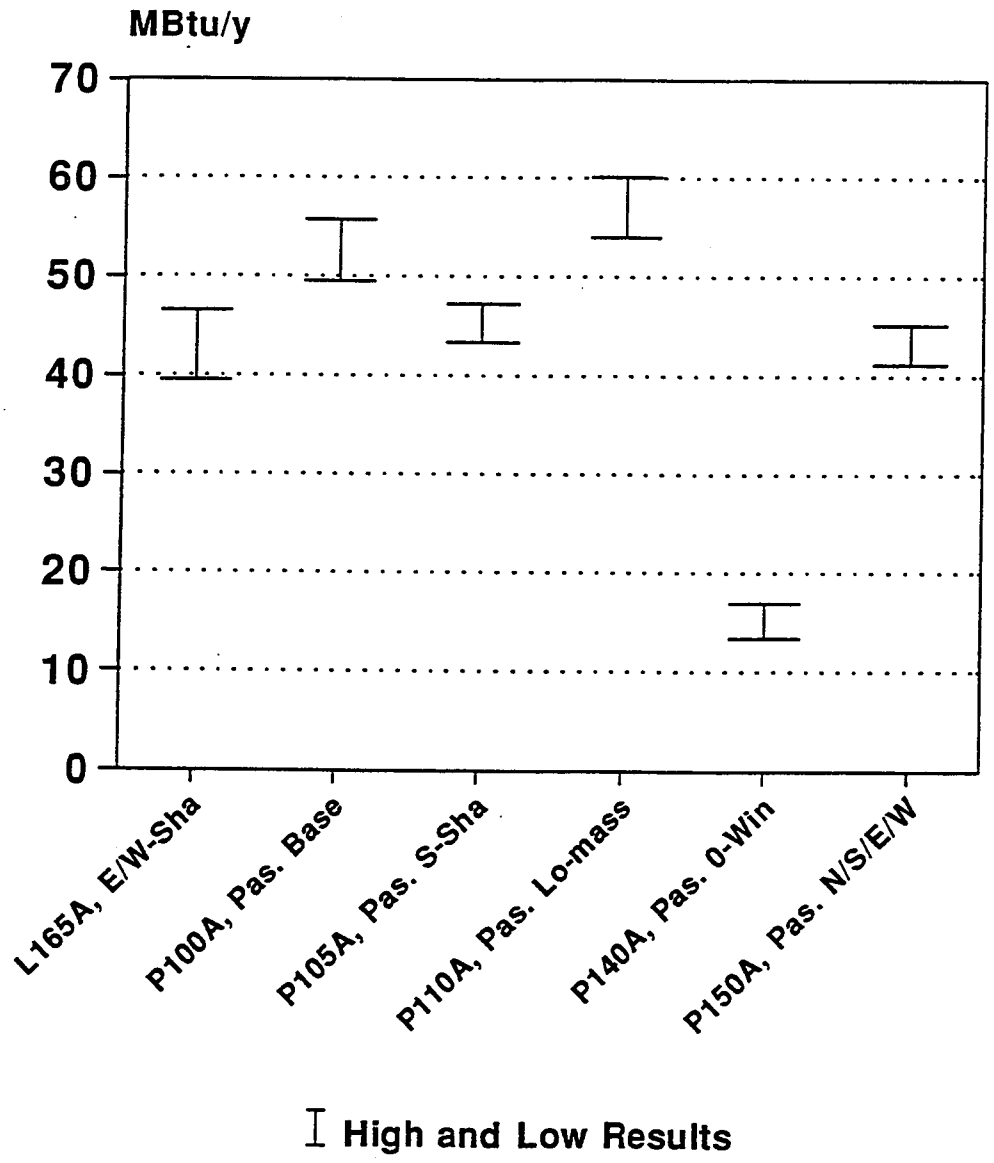

Figure 3-8. Florida-HERS BESTEST Tier 2 reference results— annual sensible cooling load for Orlando, FL.

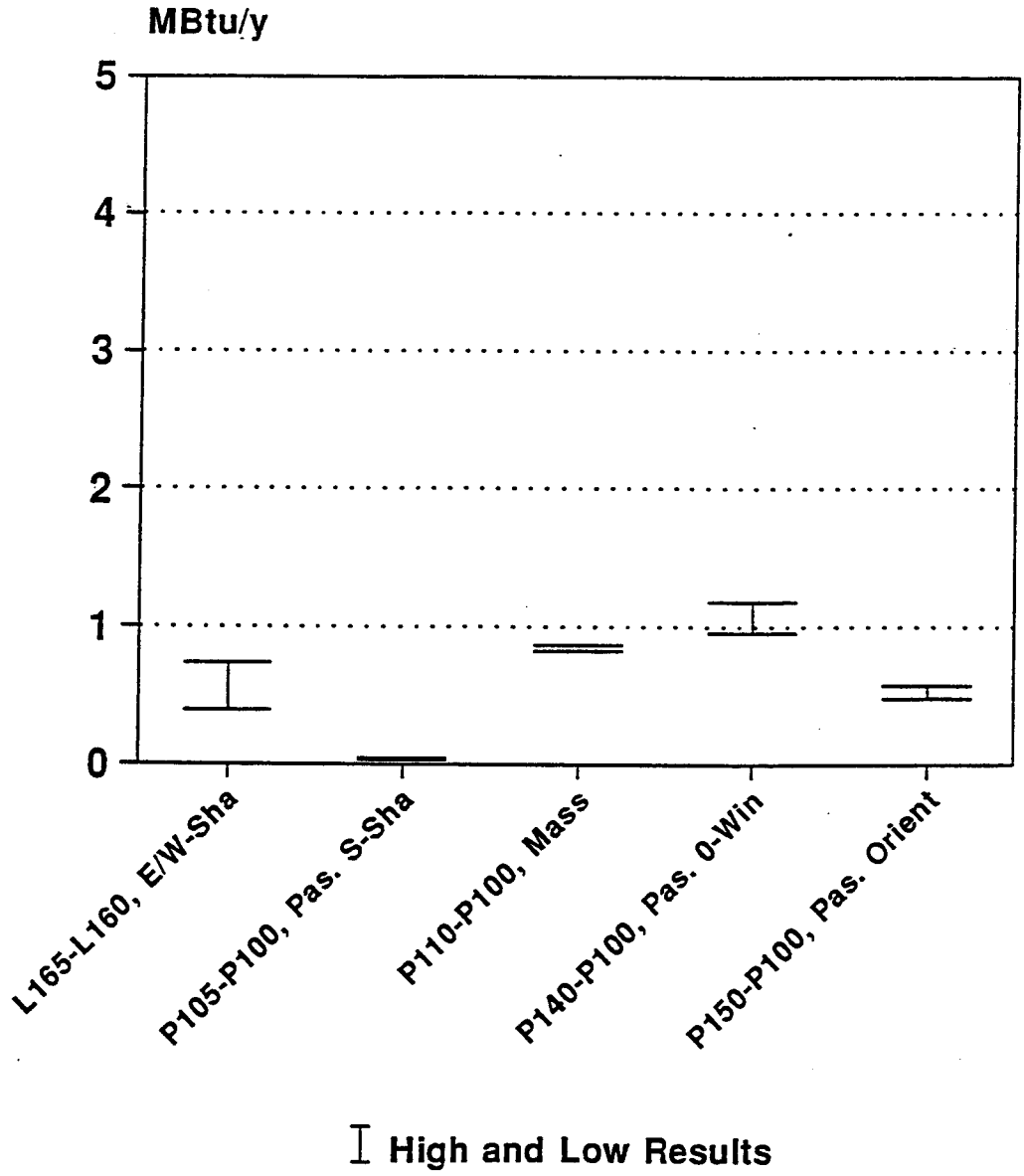

Figure 3-9. Florida-HERS BESTEST Tier 2 reference results—delta annual heating load for Orlando, FL.

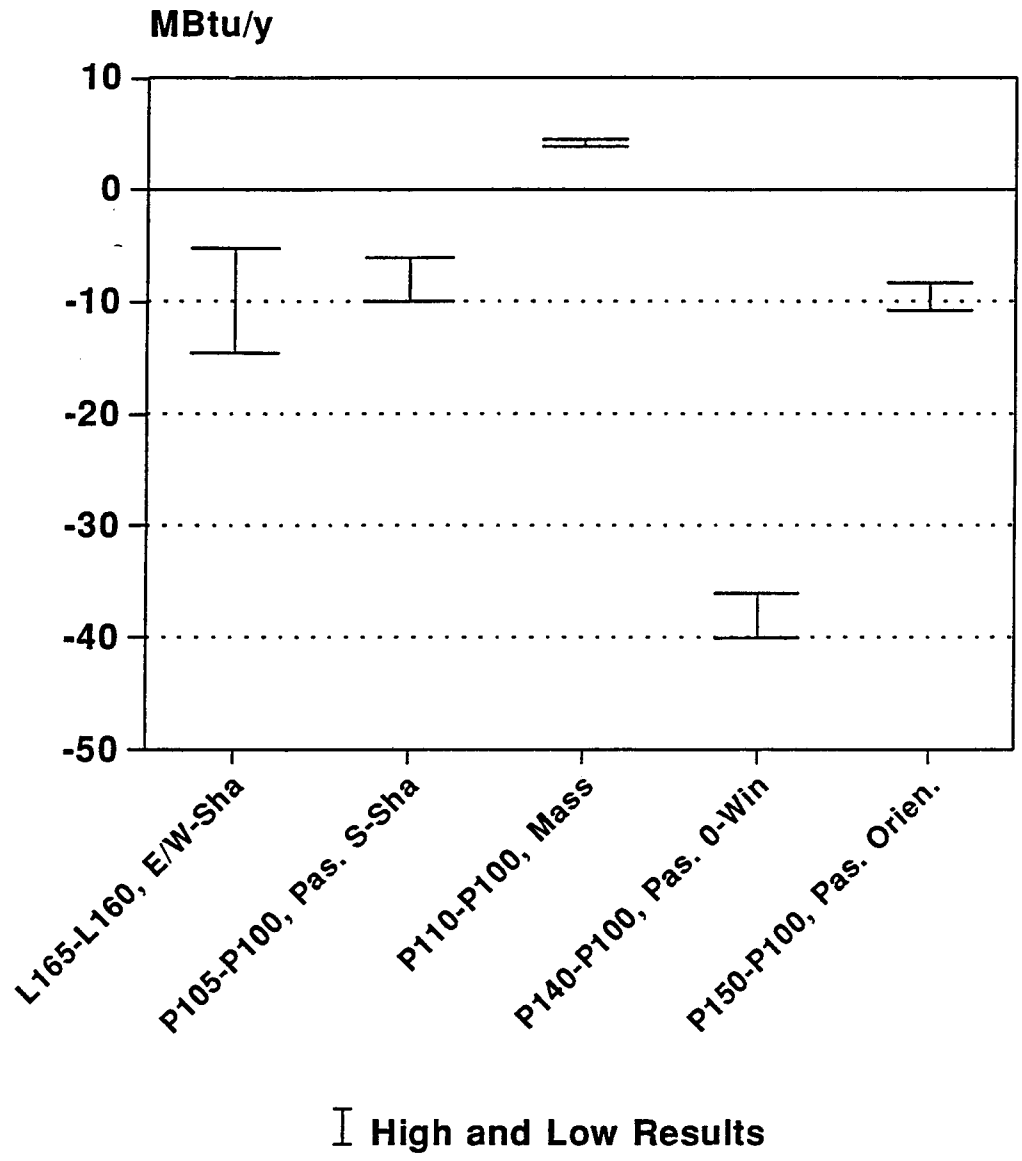

Figure 3-10. Florida-HERS BESTEST Tier 2 reference results—delta annual sensible cooling load for Orlando, FL

Table 3-6. Florida-HERS BESTEST Tier 2 Reference Results— Annual Heating and Sensible Cooling Loads for Orlando, FL

Annual Heating (MBtu/y)			
Case #	BLAST	DOE2	SERIRES/ SUNCODE
L165A	6.13	6.55	7.18
P100A	0.11	0.06	0.15
P105A	0.14	0.10	0.19
P110A	0.95	0.88	1.02
P140A	1.29	1.01	1.31
P150A	0.58	0.54	0.73

Annual Cooling (MBtu/y)			
Case #	BLAST	DOE2	SERIRES/ SUNCODE
L165A	41.47	39.56	46.64
P100A	49.54	55.77	54.09
P105A	43.51	45.85	47.35
P110A	54.08	60.13	57.99
P140A	13.43	16.96	14.05
P150A	41.30	45.08	45.29

Delta Annual Heating (MBtu/y)			
Case	BLAST	DOE2	SERIRES/ SUNCODE
L165A-L160A	0.39	0.74	0.47
P105A-P100A	0.03	0.04	0.04
P110A-P100A	0.85	0.82	0.87
P140A-P100A	1.18	0.95	1.16
P150A-P100A	0.48	0.48	0.58

Delta Annual Cooling (MBtu/y)			
Case	BLAST	DOE2	SERIRES/ SUNCODE
L165A-L160A	-5.18	-14.52	-5.49
P105A-P100A	-6.03	-9.92	-6.74
P110A-P100A	4.54	4.36	3.91
P140A-P100A	-36.11	-38.81	-40.04
P150A-P100A	-8.24	-10.69	-8.80

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Table 3-7. Florida-HERS BESTEST Tier 2 Reference Results— Monthly Heating Loads for Orlando, FL

BLAST 3.0 Monthly and Total Heating Loads (MBtu/y)						
	L165A	P100A	P105A	P110A	P140A	P150A
Jan	2.42	0.11	0.14	0.57	0.75	0.44
Feb	0.82	0.00	0.00	0.06	0.08	0.00
Mar	0.43	0.00	0.00	0.02	0.00	0.00
Apr	0.08	0.00	0.00	0.00	0.00	0.00
May	0.00	0.00	0.00	0.00	0.00	0.00
Jun	0.00	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	0.00	0.00	0.00	0.00
Aug	0.00	0.00	0.00	0.00	0.00	0.00
Sep	0.00	0.00	0.00	0.00	0.00	0.00
Oct	0.04	0.00	0.00	0.00	0.00	0.00
Nov	0.28	0.00	0.00	0.00	0.00	0.00
Dec	2.08	0.00	0.00	0.30	0.45	0.15
Tot	6.13	0.11	0.14	0.95	1.29	0.58

DOE2.1E Monthly and Total Heating Loads (MBtu/y)						
	L165A	P100A	P105A	P110A	P140A	P150A
Jan	2.50	0.06	0.10	0.51	0.63	0.40
Feb	0.91	0.00	0.00	0.07	0.04	0.00
Mar	0.49	0.00	0.00	0.03	0.00	0.00
Apr	0.10	0.00	0.00	0.00	0.00	0.00
May	0.00	0.00	0.00	0.00	0.00	0.00
Jun	0.00	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	0.00	0.00	0.00	0.00
Aug	0.00	0.00	0.00	0.00	0.00	0.00
Sep	0.00	0.00	0.00	0.00	0.00	0.00
Oct	0.06	0.00	0.00	0.00	0.00	0.00
Nov	0.36	0.00	0.00	0.00	0.00	0.00
Dec	2.14	0.00	0.00	0.27	0.34	0.14
Tot	6.55	0.06	0.10	0.88	1.01	0.54

SERIRES/SUNCODE 5.7 Monthly and Total Heating Loads (MBtu/y)						
	L165A	P100A	P105A	P110A	P140A	P150A
Jan	2.80	0.15	0.18	0.61	0.76	0.51
Feb	0.98	0.00	0.00	0.06	0.08	0.00
Mar	0.47	0.00	0.00	0.02	0.00	0.00
Apr	0.09	0.00	0.00	0.00	0.00	0.00
May	0.00	0.00	0.00	0.00	0.00	0.00
Jun	0.00	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	0.00	0.00	0.00	0.00
Aug	0.00	0.00	0.00	0.00	0.00	0.00
Sep	0.00	0.00	0.00	0.00	0.00	0.00
Oct	0.04	0.00	0.00	0.00	0.00	0.00
Nov	0.37	0.00	0.00	0.00	0.00	0.00
Dec	2.44	0.01	0.01	0.32	0.47	0.22
Tot	7.18	0.15	0.19	1.02	1.31	0.73

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Table 3-8. Florida-HERS BESTEST Tier 2 Reference Results— Monthly Sensible Cooling Loads for Orlando, FL

BLAST 3.0 Monthly and Total Sensible Cooling Loads (MBtu/y)						
	L165A	P100A	P105A	P110A	P140A	P150A
Jan	0.21	2.12	1.91	3.05	0.00	0.60
Feb	0.62	2.50	1.86	3.20	0.00	1.04
Mar	2.01	3.26	2.18	3.82	0.16	2.30
Apr	3.32	3.16	2.36	3.50	0.49	3.16
May	5.56	4.36	4.16	4.56	1.60	4.84
Jun	6.21	5.18	5.13	5.20	2.26	5.60
Jul	6.85	5.60	5.53	5.61	2.64	6.05
Aug	6.76	5.76	5.31	5.78	2.64	5.96
Sep	5.12	5.41	4.52	5.42	2.06	5.05
Oct	3.29	5.55	4.61	5.77	1.21	4.00
Nov	1.39	4.71	4.20	5.22	0.37	2.39
Dec	0.13	1.92	1.75	2.95	0.00	0.31
Tot	41.47	49.54	43.51	54.08	13.43	41.30

DOE2.1E Monthly and Total Sensible Cooling Loads (MBtu/y)						
	L165A	P100A	P105A	P110A	P140A	P150A
Jan	0.31	2.91	2.54	3.89	0.03	0.93
Feb	0.66	3.27	2.62	3.94	0.06	1.42
Mar	2.03	3.85	2.78	4.35	0.41	2.67
Apr	3.21	3.50	2.45	3.84	0.86	3.43
May	5.21	4.48	3.98	4.65	2.05	5.05
Jun	5.73	5.20	4.86	5.22	2.72	5.78
Jul	6.31	5.69	5.32	5.70	3.10	6.23
Aug	6.22	6.02	5.26	6.03	3.07	6.15
Sep	4.87	6.03	4.56	6.04	2.50	5.39
Oct	3.29	6.38	4.59	6.57	1.60	4.48
Nov	1.51	5.67	4.58	6.12	0.57	2.92
Dec	0.18	2.76	2.32	3.77	0.00	0.62
Tot	39.56	55.77	45.85	60.13	16.96	45.08

SERIRES/SUNCODE 5.7 Monthly and Total Sensible Cooling Loads (MBtu/y)						
	L165A	P100A	P105A	P110A	P140A	P150A
Jan	0.28	2.33	2.07	3.12	0.00	0.76
Feb	0.77	2.80	2.12	3.42	0.00	1.31
Mar	2.44	3.67	2.46	4.12	0.21	2.71
Apr	3.86	3.55	2.59	3.87	0.58	3.55
May	6.18	4.69	4.47	4.85	1.68	5.21
Jun	6.87	5.53	5.48	5.55	2.34	5.96
Jul	7.56	5.99	5.89	6.00	2.72	6.41
Aug	7.36	6.14	5.62	6.16	2.70	6.28
Sep	5.81	6.01	4.95	6.02	2.17	5.52
Oct	3.75	6.08	5.08	6.28	1.28	4.41
Nov	1.58	5.12	4.61	5.56	0.39	2.70
Dec	0.19	2.19	2.00	3.04	0.00	0.49
Tot	46.64	54.09	47.35	57.99	14.05	45.29

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13. ABSTRACT *(Maximum 200 words)* In 1991, the U.S. Department of Energy, in cooperation with the Department of Housing and Urban Development (HUD), initiated a collaborative process to define a residential energy efficiency rating program linked with energy-efficient mortgage (EEM) financing. During this process, the collaborative, consisting of a broad-based group representing stakeholder organizations, identified the need for quality control procedures to evaluate and verify the energy prediction methods used by Home Energy Rating System (HERS) providers. Such procedures were needed so a variety of locally developed rating systems would have equal opportunity to qualify under the umbrella of a national HERS/EEM system by meeting minimum technical requirements (National Renewable Energy Laboratory).

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